IS 5613 (Part 3/Sec 1) : 1989
(Reaffirmed 2004)
(Reaffirmed 2014)
(Reaffirmed 2019)

भारतीय मानक

शिरोपरि पावर लाइनों की डिजाइन, संस्थापन और रखरखाव की रीति संहिता

भाग 3 400 कि वो लाइनें

अनुभाग 1 डिजाइन

Indian Standard

CODE OF PRACTICE FOR DESIGN, INSTALLATION AND MAINTENANCE FOR OVERHEAD POWER LINES

PART 3 400 kV LINES

Section 1 Design

Second Reprint SEPTEMBER 2007
(Including Amendment No. 1)

UDC 621.315.17

© BIS 1990

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 1990 **Price Group 7 + Gr 2**

Conductors and Accessories for Overhead Lines Sectional Committee, ETDC 60

FOREWORD

This Indian Standard (Part 3/Sec 1) was adopted by the Bureau of Indian Standards on 23 March 1989, after the draft finalized by the Conductors and Accessories for Overhead Lines Sectional Committee had been approved by the Electrotechnical Division Council.

The present strategy for development of power has necessitated a rapid development of extensive extra high voltage (EHV) network covering the whole country. After successful introduction of 220 kV system in the country, 400 kV has been adopted as the next higher system voltage after detailed techno-economic studies. For the development of 400 kV network, this code, in addition to specifying the good practices for EHV lines, gives in particular the detailed requirements for towers, conductors and other associated accessories suitable for 400 kV system.

While preparing this specification considerable assistance has been taken from the report of the Committee for Standardization of Parameters and Specifications for Major Items for 400 kV Sub-station Equipment and Transmission Line Materials (1984) published by the Central Electricity Authority, Department of Power. Ministry of Energy, New Delhi.

In order to cover all the system voltage(s), this standard has been prepared in the following three parts:

Part 1 Lines up to and including 11 kV,

Part 2 Lines above 11 kV and up to and including 220 kV, and

Part 3 400 kV Lines.

Each part has been further divided into two sections. Section 1 covers design aspects while Section 2 covers installation and maintenance of overhead power lines.

Indian Standard

CODE OF PRACTICE FOR DESIGN, INSTALLATION AND MAINTENANCE FOR OVERHEAD POWER LINES

PART 3 400 kV LINES

Section 1 Design

1 SCOPE

1.1 This code (Part 3/Sec 1) covers design of 400 kV transmission lines.

1.2 This code does not cover switching control, relay protection, coordination with telecommunication lines and radio-interference.

2 REFERENCES

2.1 The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this code, the definitions given in IS 1885 (Part 30) : 1971 and the *Indian Electricity Rules, 1956* shall apply.

4 GENERAL

4.1 Conformity with *Indian Electricity Rules* and Regulations of other Authorities — All overhead lines shall comply with the requirements of the *Indian Electricity Act* and Rules made thereunder, and the regulations or specifications as laid down by Railway Authorities, Post and Telegraphs, Roadways, Navigation or Aviation Authorities, local governing bodies, Defence Authorities, Power and Telecommunication Coordination Committee, Forest and Environment Authorities etc, wherever applicable. Relevant matters requiring attention of such authorities should be referred to them and their approval obtained before planning the layout, installation and construction work. Such references, however shall be made by the owner of the installations and within appropriate time so as to ensure smooth progress. The Rules No. 29, 51, 74 to 93 of the *Indian Electricity Rules, 1956* are particularly applicable.

4.2 It is essential that before proceeding with the design, the site conditions are known as best as possible. The available design should further be oriented taking into account the difficulties likely to be encountered during installation and maintenance.

5 CHOICE OF ROUTE

5.1 The proposed route of line should be the shortest practicable distance. The following factors shall be considered in the choice of the route:

a) Line should be approachable. Difficult and unsafe approaches should be avoided.

b) Route should be as short and as straight as possible.

c) Number of angle towers should be minimum and within these, the number of heavier angle towers shall be as small as possible.

d) Good farming areas, uneven terrains, religious places, civil and defence installations, industries, aerodromes and their approach and take-off funnels, public and private premises, ponds, tanks, lakes, gardens and plantations should be avoided as far as practicable.

e) Cost of securing and clearing right-of-way (ROW), making access roads and the time required for these works should be minimum.

f) Line should be as away as possible from telecommunication lines and should not run parallel to these.

g) Crossing with permanent objects, such as, railway lines and roads should be minimum and preferably at right angles. Reference shall be made to the appropriate railways regulations and railways electrification rules as well as civil authorities for protection to be provided for railway and road crossings, respectively.

h) A detour in the route is preferable so that it should be capable to take care of future load developments without major modifications.

j) Line should be away from the buildings containing explosives, bulk storage oil tanks, oil or gas pipelines.

5.2 In case of hilly terrain having sharp rises and falls in the ground profile, it is necessary to conduct detailed survey before finalizing the tower

and line design data. This will provide most economical proposition for the installation.

6 ELECTRICAL DESIGN

6.1 General

The electrical design of the lines shall be carried out in accordance with the established design practices taking into consideration the power system as a whole, and shall cover the following.

6.1.1 *Transmission Voltage*

The transmission voltage applicable for this standard shall be 400 kV in accordance with the recommendations of IS 12360 : 1988. Besides other considerations, the following factors should be considered before making the choice of the voltage:

a) Magnitude of the power to be transmitted,

b) Length of the line,

c) Cost of the terminal equipment, and

d) Economy consistent with the desired reliability.

6.1.2 *Insulation Requirements*

The insulation levels shall be selected in accordance with IS 2165 (Part 1) : 1977, IS 2165 (Part 2) : 1983 and IS 3716 : 1978.

7 STRUCTURES

7.1 Towers

The design and material of the towers shall conform to IS 802 (Part 1) : 1977.

7.1.1 In case of hot-dip galvanized structures, galvanizing shall conform to IS 2633 : 1986, IS 4759 : 1984 and IS 1367 (Part 13) : 1983. For spring washers, electrogalvanizing in accordance with IS 1573 : 1986 shall be acceptable.

7.2 Choice of Spans

The following factors influence the choice of span:

a) Terrain conditions,

b) Economic construction and maintenance cost, and

c) Ease of construction and maintenance.

7.2.1 *Ruling (Equivalent) Span*

For erecting an overhead line, all the spans cannot be kept equal because of the profile of the land and proper clearance considerations. If this were done, adjustments of tensions would be necessary in adjacent spans since any alteration in temperature and loading would result in unequal tension in the various spans. This is obviously impracticable as a constant tension should be applied at the tensioning position and this constant tension shall be uniform throughout the whole of the section. With suspension insulators, the tension unequalities is compensated by string deflections. Therefore, a constant tension is calculated which will be uniform throughout the section. For calculating this uniform tension, an equivalent span for the whole length of the line is chosen. The ruling span is then calculated by the following formulae.

$$L_R = \sqrt{\frac{L_1^3 + L_2^3 + L_3^3 + \ldots}{L_1 + L_2 + L_3 + \ldots\ldots}}$$

where

L_R = ruling span, and L_1, L_2, etc=different spans in a section. Having determined the ruling span and basic tension, the sag of actual span may be calculated by the following formula:

$$S = \left[\frac{\text{Actual span}}{\text{Ruling span}}\right]^2 \times S_R$$

where

S = sag for actual span, and S_R = sag for ruling span.

NOTES

1 For ready reference, tensions may be calculated for different sizes of conductors for different span lengths and at different temperatures and plotting as sag tension charts.

2 For the limitation regarding weight span and wind span, reference shall be made to IS 802 (Part 1) : 1977 as well as Annex A of IS 5613 (Part 2/ Sec 2) : 1985

7.3 Typical Structure Configuration

7.3.1 The typical tower configuration for single circuit and double circuit transmission lines is shown in Fig. 1.

7.4 Tower Loadings

7.4.1 *Normal Condition*

a) *Transverse loads*

1) Wind on wires,

2) Wind on insulators,

3) Line deviation, and

4) Wind on tower.

b) *Vertical loads* (*uplift or down thrust*)

1) Weight of wires;

2) Weight of ice, if any;

3) Weight of insulators and accessories; and

4) Erection load.

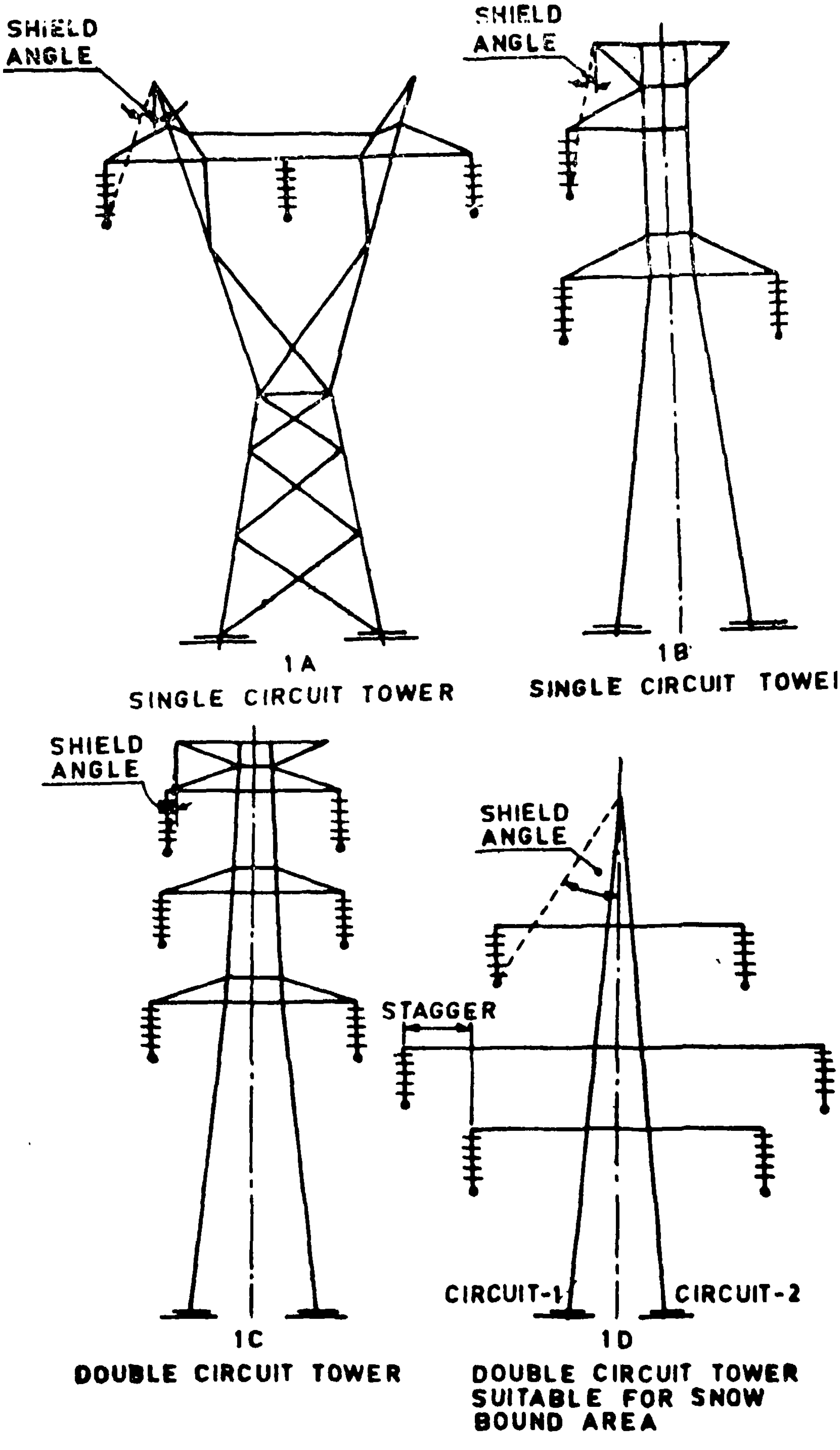


FIG. 1 TYPICAL TOWER CONFIGURATION FOR SINGLE CIRCUIT AND DOUBLE CIRCUIT TRANSMISSION LINES

NOTES

1 If there is no uplift on the wires as observed by applying the sag template in accordance with Appendix A of IS 5613 (Part 2/Sec 2) : 1976 the tension of the wires acts downwards. If there is uplift, the tension of the wires acts upwards and has to be considered for design of tension tower.

2 The ice on the conductor is classified as glazed (ice), rime, wet snow and hoar frost. The unit weight of glaze (ice), rime (soft/hard), wet snow and hoar frost shall be taken as 900 to 920 kg/m^3. 300 to 900 kg/m^3, 300 to 800 kg/m^3 and 300 kg/m^3, respectively. The ice coating on structure themselves may be ignored for design purpose.

c) *Loads due to unbalanced tensions,* unbalanced tension on angle towers.

7.4.2 *Broken Wire Conditions*

a) As in **7.4.1** and (b) above, modified for broken wire effect, and

b) Longitudinal loads.

7.5 Tower Accessories

7.5.1 *Number Plates*

These shall conform to Fig. 2.

7.5.2 *Danger Notice Plates*

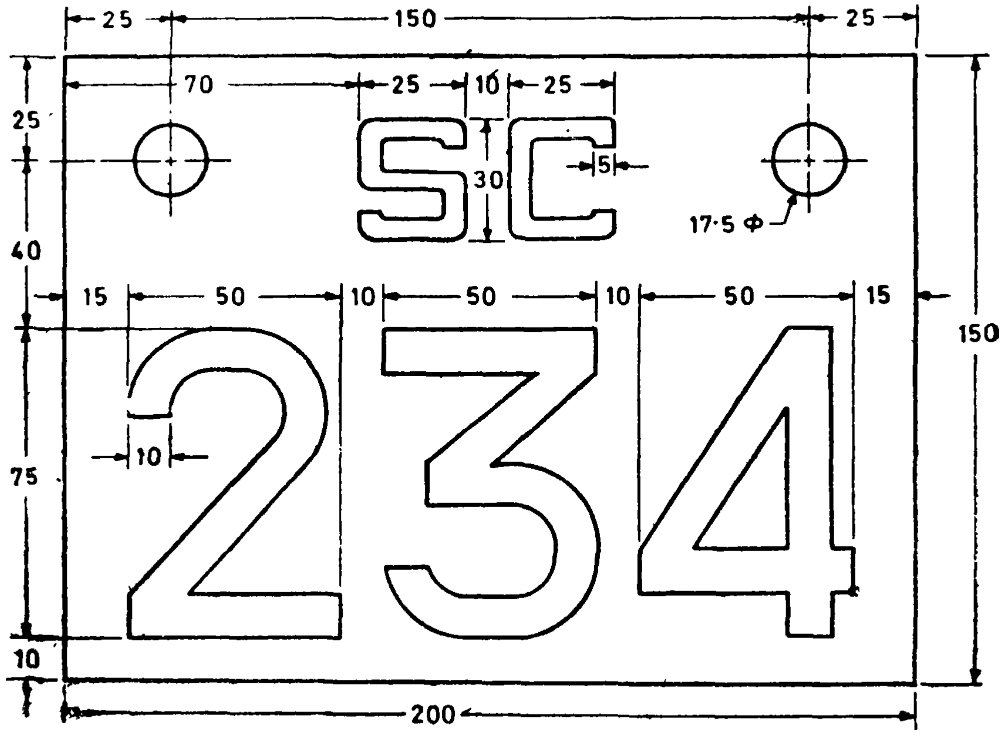
These shall conform to IS 2551 : 1982.

7.5.3 *Phase Plates*

These shall be in sets of red, yellow and blue colours and shall conform to Fig. 3.

7.5.4 *Circuit Plates*

These shall conform to Fig. 4.



NOTES

1 Lettering should be in red enamelled on white background.

2 The rear side of the plate shall be enamelled black.

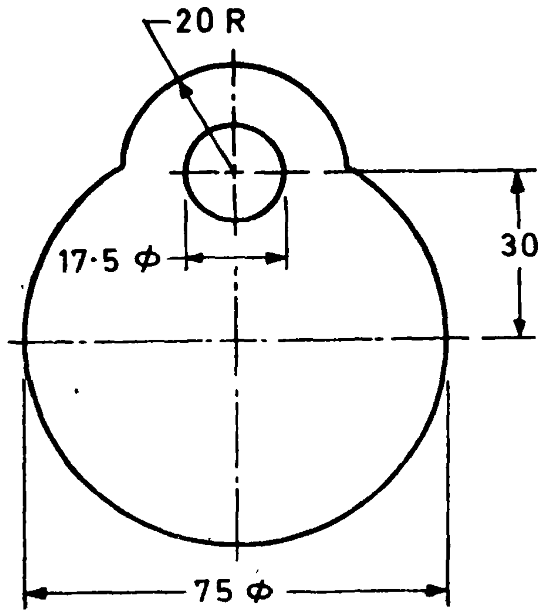
3 The plate shall be of minimum 1.6 mm thick mild steel sheet.

4 For number plate, numbering shall be in the sequence of tower numbers as per specification.

5 'SC' represents first letter of starting and ending place of line respectively.

All dimensions in millimetres.

FIG. 2 NUMBER PLATE



NOTES

1 One set consisting of 3 plates having red, blue and yellow colours shall be required for single circuit line.

2 Two sets each consisting of 3 plates having red, blue and yellow colours shall be required for double circuit line.

3 The plate shall be of minimum 1.6 mm thick mild steel sheet. Front and back of the plate shall be enamelled: Front with colours as per notes 1 and 2 and back shall be enamelled black.

All dimensions in milimetres.

FIG. 3 PHASE PLATE

7.5.5 *Anticlimbing Device*

These shall conform to the specifications laid down by the user of the installation. A typical example of providing anticlimbing device is given in Fig. 5.

7.5.6 *Step-Bolts*

The step-bolt shall be provided on leg No. 1 (*see* Fig. 6) of the tower starting from 2.5 m above the ground level and spaced at a maximum distance of 450 mm centre to centre up to the top of the tower. In case of double circuit lines for the sake of convenience of maintenance, the user may specify the provisions of step bolt on diagonally opposite legs (that is, leg No. 1 and 3 in Fig. 6). The step bolt shall not be less than 16 mm diameter and length 150 mm. The step bolt shall have hexagonal head or button head.

7.5.7 Arrangements shall be provided for fixing the accessories (covered in **7.5.1** to **7.5.5**) to the tower at a height between 2.5 and 3.5 mm above ground level.

7.5.8 *Bird Guards*

These shall be saw tooth type and shall be fixed over the suspension insulator strings (*see* Fig. 7). Bird guards shall be used for type 1 strings only.

7.6 Towers

The design, material, fabrication and testing of the towers shall conform to IS 802 (Part 1) : 1977, IS 802 (Part 2) : 1978 and IS 802 (Part 3) : 1978. Technical particulars of a typical tower for 400 kV are given in Annex B.

8 POWER CONDUCTORS AND ACCESSORIES

8.1 Power Conductors

Conductor for EHV transmission lines shall conform to IS 398 (Part 5) : 1982.

8.2 Accessories for Power Conductors

The various accessories associated with the power conductors shall conform to the following Indian Standards:

IS 2121 (Parts 1 and 2) : 1981, IS 9708 : 1980 and IS 10162 : 1982.

9 EARTH CONDUCTOR AND ACCESSORIES

9.1 Galvanized steel wires shall be used for ground wires. For 400 kV lines, the size of ground wire shall be 7/3.66 mm having a minimum tensile strength of 95 kg/mm^2. The purity of steel shall be as follows:

a) Sulphur and phosphorus contents not exceeding 0.045 percent each, and

b) Carbon content not exceeding 0.55 percent.

9.2 Ground Wire Accessories

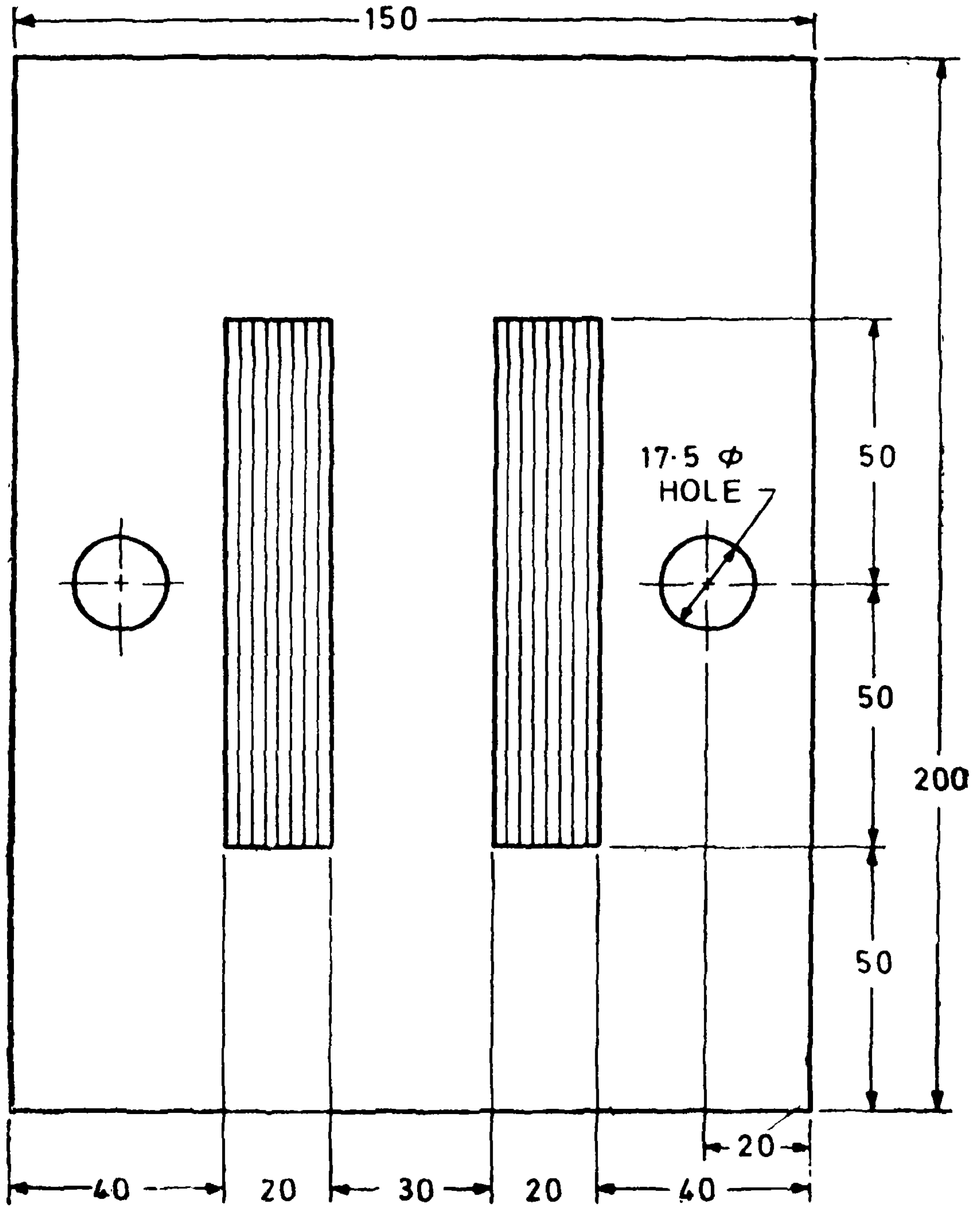
9.2.1 *Mid-Span Compression Joints*

The material for mid-span compression joint shall be galvanised mild steel.

9.2.1.1 The minimum failing load of the joints shall not be less than 95 percent of the breaking load of the ground wire.

9.2.2 *Suspension Clamps*

The material for suspension clamps shall be malleable cast iron/forged steel. Minimum failing load shall be not less than the breaking load of ground wire. The slip strength shall be not less than 25 to 30 percent of the breaking load of the ground wire.



NOTES

1 Letting should be in red enamelled on white background.

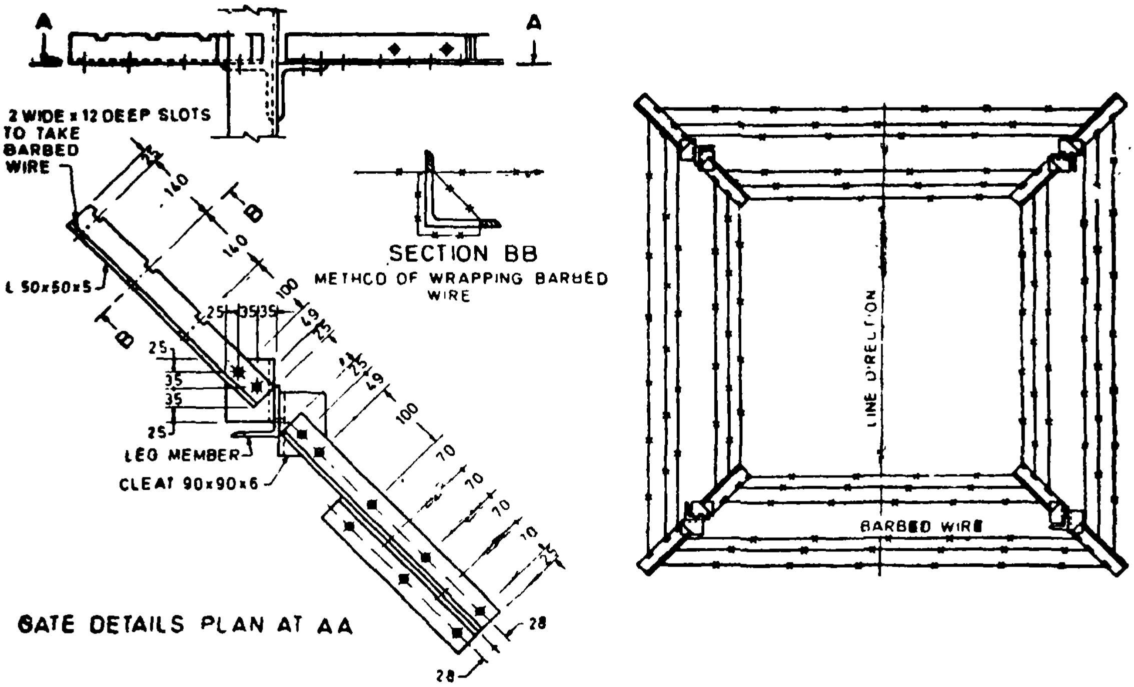
2 Rear side of the plate shall be enamelled black.

3 One set consists of 2 such plates with markings '**I**' and '**II**' for duoble circuit tower only.

4 The material of the plate shall be of mild steel having minimum thickness 1.6 mm.

All dimensions in millimetres.

FIG. 4 CIRCUIT PLATE



NOTES

1 All holes are 17.5 mm diameter to suit 16 mm diameter bolts.

2 Bank holes at gates are to receive barbed wire.

3 One 3-mm spring washer to be provided under each nut

All dimensions in millimetres.

FIG. 5 DETAIL OF ANTICLIMBING DEVICE

9.2.3 *Tension Clamps*

The body of compression type tension clamps shall be of stainless steel grade 07G19N19 conforming to appropriate part of IS 1570, (EN58A) grade or equivalent with brinell hardness not exceeding 200. The minimum failing load and minimum slip strength shall be not less than 95 percent and 90 percent, respectively of the breaking load of the ground wire.

9.2.4 *Earthing Bonds*

Tinned coppers tranded wire of 37/7/0.47 mm shall be used for earthing bonds. The bond shall be tested by applying a pull of 300 kg between the two ends of the bonds, the stranded cable shall not come out of the connecting less and none of its strands shall be damage.

10 EARTHING

10.1 All metal supports and metallic fittings attached thereto, shall be permanently and efficiently earthed.

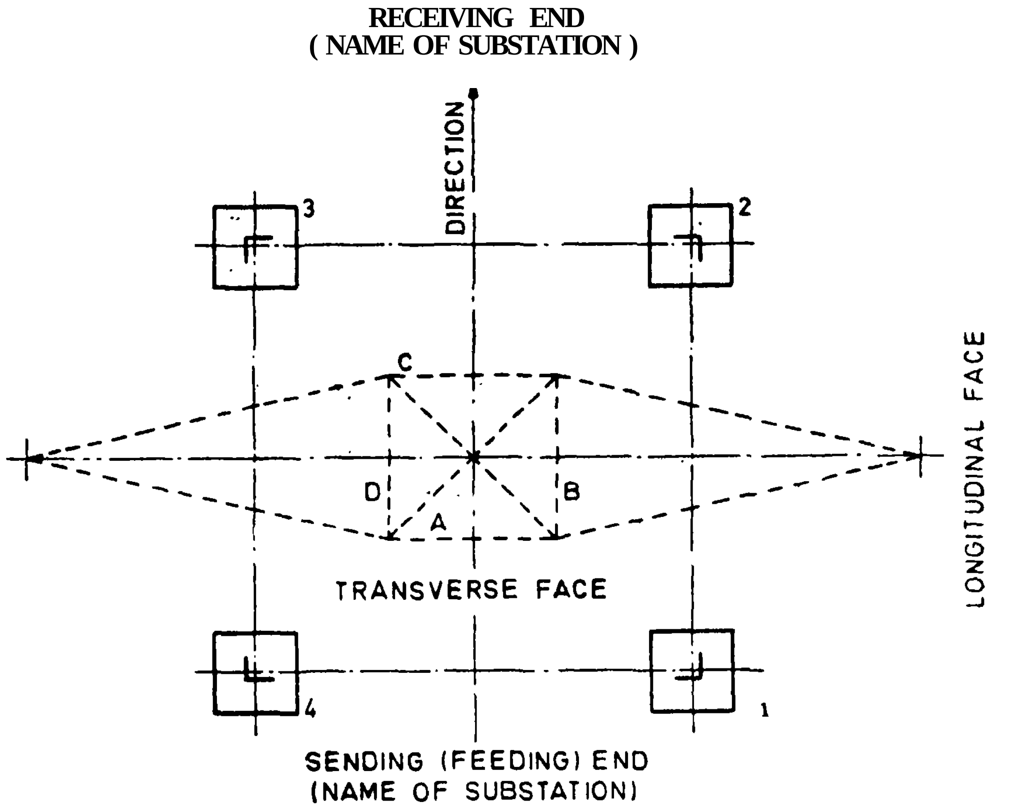
10.2 Earthing in each case shall conform to the requirements given in Section **2** of this standard and also to IS 3043 : 1987.

11 MAXIMUM WORKING TENSION

11.1 Where the actual span is different from the ruling span, the maximum working tension shall not exceed the tension for which the towers are designed.

11.2 For any difference between the conductor tension in adjacent line sections, the relevant section tower shall be checked for its capacity to withstand the resulting unbalanced longitudinal loads together with the other existing loadings according to design specifications and the position of the tower.

11.3 The still air ground wire sag shall not exceed 90 percent of the power conductor sag within the specified range of temperature so as to ensure that the minimum shield angle is maintained and the minimum specified mid-span clearance is not encroached upon (*see* **14.1.3**).



1 represents leg or pit No. 1
2 represents leg or pit No. 2
3 represents leg or pit No. 3
4 represents leg or pit No. 4

A represents near side (NS) transverse face
B represents near side (NS) longitudinal face
C represents far side (FS) transverse face
D represents far side (FS) longitudinal face

NOTES

1 Danger and number plates are located on face *'A'*

2 Leg 1 represents the leg with step bolts and anti-climb device gate, if any. If two legs with step bolts are required, the next is No. 3 leg.

FIG. 6 DESIGNATION OF TOWER LEGS, FOOTINGS AND FACES

11.4 For long spans (where sag exceeds 6 percent of the span length) and spans with steep slopes, the tension at supports exceeds the horizontal conductor tension obtained by the usual sag-tension calculations. If support tension exceeds 50 percent of the rated ultimate tensile strength of conductor, the specified safety factors for sag-tension calculations shall be suitably increased.

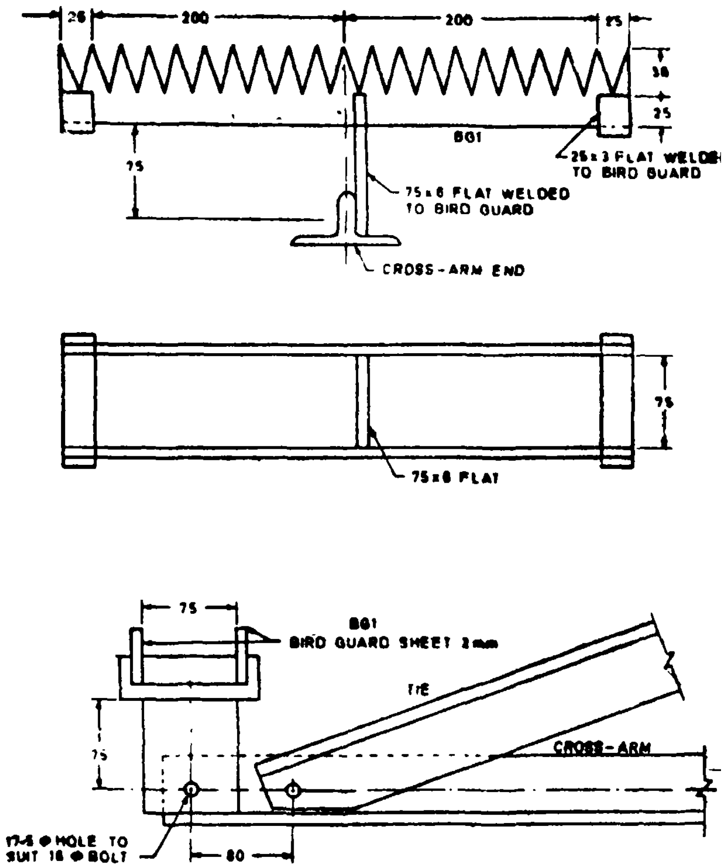
11.5 For general theory of sag and tension calculation, reference shall be made to **7** of IS 5613 (Part 1/Sec 1) : 1985. An example of sag and tension calculations for ACSR conductors is given in Appendix A of IS 5613 (Part 2/Sec 1) : 1985.

12 INSULATORS AND FITTING

12.1 Disc Insulators

Standard disc insulators of ball and socket type conforming to IS 731 : 1971 and IS 3188 : 1980 shall be used. For 400 kV lines, use of discs of the size of 255/280 x 145 mm of 120 kN electro-mechanical strength for suspension string and 280 x 170 mm of 160 kN electromechanical strength for tension string is recommended.

The insulator string shall have enough number of insulator discs so that adequate conductor to tower clearances is achieved and the string should



NOTE — All parts to be galvanized.

All dimensions in millimetres

FIG. 7 BIRD GUARD

be able to withstand the flashover characteristics estimated for over-voltage conditions.

12.2 Insulator String Hardware

12.2.1 *Suspension Clamp*

Free centre or armour grip suspension type to clamps shall be used so as to ensure reliability against mechanical strength and conductor vibration. The material of the body shall be gravity die cast, high strength corrosion resistant aluminium alloy.

12.2.2 *Tension Clamp*

The compression type of tension clamps shall be used. The outer sleeve of the clamps shall be of EC grade aluminium tube formed by extrusion process and inner sleeve shall be of galvanized low carbon forged steel. The clamp shall be able to withstand a minimum failing load of 95 percent of the breaking load of the conductor.

12.2.3 *Arcing Horns on Tower Side*

These shall be loop or ball ended type and shall be made out of galvanized mild steel tube/rod.

12.2.4 *Grading/Corona Ring*

These shall be made of aluminium alloy tube/ galvanized mild steel tube.

13 FOUNDATIONS

13.1 The foundation designs shall conform to IS 456 : 1978 and IS 4091 : 1979.

14 CLEARANCES

14.1 The minimum clearances shall meet with the requirements given in following clauses.

14.1.1 Minimum ground clearance from lowest point of power conductor shall be 8 840 mm.

NOTE — Extra allowance may be made to provide for creep, undulation in terrain, etc.

14.1.2 Minimum mid-span vertical clearance between power conductor and ground wire in still air at normal design span shall be 9 000 mm.

14.1.3 The earth wire sag shall be not more than 90 percent of the corresponding sag of power conductor under still air conditions for the entire specified temperature range.

14.1.4 Minimum clearance from line parts to tower body and cross-arm members in the case of 400 kV lines shall be in accordance with Table 1.

14.2 Clearance Between the Overhead Line and the Railway Track

14.2.1 Clearance between the overhead line and railway track shall be in accordance with the Regulations for Electricals Crossings of Railway Tracks laid down by the Railway Authorities.

14.2.1.1 *Vertical clearances*

The minimum height above rail level of the lowest portion of any conductor of a crossing, including grand wire, under conditions of maximum shall be as follows:

Voltages	*Broad, Metre and Narrow Gauge*
Above 220 kV and up to 400 kV	19.30 metres

NOTE — While calculating the above clearances, railways high tension lines running over the 1 500 V dc traction structure in some sections have not been taken into consideration. Where such high tension lines exist, the height above the rail level of the highest high tension line shall be taken into account for calculating the clearances.

Table 1 Swing Angles and Minimum Clearances from Live Parts to Tower Body/Cross-Arm Members

(*Clauses* 14.1.4 *and* B-6.2)

Wind Pressure kg/m^2	Angle of Swing				
	Insulator String		Jumper Swing		
			Switching Surge Over-Voltage		Power Frequency Over Voltages
	Normal Swing	Maximum Swing	Normal Swing	Maximum Swing	Maximum Swing
(1)	(2)	(3)	(4)	(5)	(6)
43	21°(15°)	42°(30°)	26°(20°)	(40°)	(52°)
45	22°(15°)	44°(30°)	31°(20°)	(40°)	(62°)
52	24°(15°)	48°(30°)	34°(20°)	(40°)	(68°)
Clearances mm	3 050	1 860	3 050	(1 860)	(3 050)

NOTE — The values given in the brackets are the revised values. It is proposed to ultimately retain the revised values only and delete the old values.

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
IS 398	Specification for aluminium conductors for overhead purposes
(Part 5) : 1982	Aluminium conductors—galvanized steel — reinforced for extra high voltage (400 kV and above)
IS 456 : 1978	Code of practice for plain and reinforced concrete (*third revision*)
IS 731 : 1971	Specification for porcelain insulators for overhead power lines with a nominal voltage greater than 1 000 V (*second revision*)
IS 802	Code of practice for use of structural steel in overhead transmission line towers
(Part 1) : 1977	Loads and permissible stresses
(Part 2) : 1978	Fabrication, galvanizing, inspection and packing
(Part 3) : 1978	Testing
IS 1367	Technical supply conditions for threaded steel fastners
(Part 13) : 1983	Hot dip galvanized coatings on threaded fasteners (*second revision*)
IS 1570 (in parts)	Schedules for wrought steels

IS No.	Title
IS 1573 : 1986	Electroplated coatings of zinc on iron and steel (*second revision*)
IS 1885 (Part 30) : 1971	Electrotechnical vocabulary : Part 30 overhead transmissions and distribution of electrical energy
IS 2121	Specification for conductors and earth wire accessones for overhead power lines
(Part 1) : 1981	Armour rods, binding wires and tapes (*first revision*)
(Part 2) : 1981	Mid-span joints and repair sleeves (*first revision)*
IS 2165	Insulation co-ordination
(Part 1) : 1977	Phase to earth insulation coordination, principles and rules (*second revision*)
(Part 2): 1983	Phase to phase insulation co-ordination, principles and rules
IS 2551 : 1982	Specification for danger notice plates (*first revision)*
IS 2633 : 1986	Methods of testing uniformity of coating of zinc coated articles (*second revision*)
IS 3043 : 1987	Code of practice for earthing (*first revision)*
IS 3188 : 1980	Characteristics of string insulator units (*first revision)*
IS 3716 : 1978	Application guide for insulation coordination (*first revision*)
IS 4091 : 1979	Code of practice for design and construction of foundations for transmission line towers and poles (*first revision*)
IS 4759 : 1984	Hot-dip zinc coatings on structural steel and other allied products (*second revision*)
IS 5613	Code of practice for design, installation and maintenance of overhead power lines
(Part 1/Sec 1) : 1985	Lines up to and including 11 kV, Section 1 Design (*first revision*)
(Part 2/Sec 1) : 1985	Lines above 11 kV and up to and including 220 kV, Section 1 design (*first revision*)
(Part 2/Sec 2) : 1985	Lines above 11 kV and up to and including 220 kV, Section 2 installation and maintenance
IS 9708 - 1980	Specification for stockbridge vibration dampers for overhead power lines
IS 10162 : 1982	Specification for spacers and spacer dampers for twin horizontal bundle conductors
IS 12360 : 1988	Voltage bands for electrical installations including preferred voltages and frequency

ANNEX B

(*Clause* 7.6)

TECHNICAL PARTICULARS FOR TYPICAL TOWERS FOR 400 kV LINES

B-1 GENERAL

B-1.1 Configuration — Horizontal

B-1.2 Type of Towers

a) Suspension towers (0-2°)

b) Small angle tension towers (2-15°)

c) Medium angle tension towers (15-30°)

d) Large angle tension towers/dead end towers (30-60°/dead end)

B-1.3 Normal Span — 400 metres

B-1.4 Wind Span — Equal to normal span

B-1.5 Weight Span	
Maximum	1.5 x normal span
Minimum	0.80 x normal span

NOTE — The cross arms for medium and heavy angle towers shall be suitable for a weight span of 3 times. the normal span.

B-1.6 Maximum Temperature of Current Carrying Power Conductor Exposed to Sun	75°C
B-1.7 Maximum Temperature of Groundwire Exposed to Sun	53°C
B-1.8 Maximum Wind Pressure and Minimum Temperature Conditions	As in Fig. 1 of IS 802 (Part 1): 1977

B-2 CONDUCTORS

B-2.1 Number of Subconductors per Phase	Two
B-2.2 Spacing Between Subconductors	450 mm
B-2.3 Bundle Arrangement	Horizontal

B-3 EARTHWIRE

B-3.1 Number of Earthwires	Two
B-3.2 Shielding Angle	20°

B-4 INSULATOR STRINGS

B-4.1 Maximum Length of Suspension Strings from Shackle Attachment at Hanger to Centre Line of Conductor	3 850 mm
B-4.2 Maximum Length of Tension Strings from Tower Attachment to Compression Dead-End Attachment	5 600 mm 5 450 mm, *Min*
B-5 HANGER	300 mm

B-6 CLEARANCES

B-6.1 Minimum Ground Clearance from Lowest Point of Power Conductor	8 840 mm*
B-6.2 Minimum Clearance from Live Parts to Tower Body and Cross-Arm Members	As in Table *1*
B-6.3 Minimum Mid-Span Vertical Clearance Between Power Conductor and Ground Wire in Still Air	9 000 mm

B-7 BROKEN WIRE CONDITION

B-7.1 Suspension Towers	Any groundwire or bundle whichever is more stringent for a particular member
B-7.2 Tension Towers	Any groundwire or bundle whichever is more stringent for a particular member

B-8 LOADINGS

B-8.1 Loadings shall be Determined for the Two Loading Combinations Given Below:

a) Combination **I**	Corresponding to maximum wind at mean annual temperature
b) Combination **II**	Corresponding to 2/3 maximum wind at the minimum temperature.

*Extra allowance may be made to provide for creep, undulation in terrain, etc,

B-8.2 Transverse Loads

B-8.2.1 ***Windloads***	*Normal Condition*	*Broken Wire Condition*
a) On conductors and groundwires on full projected areas	Corresponding to full wind span of bundled conductors and groundwire	Corresponding to 50 percent of intact span and 10 percent of broken span of bundled conductor/groundwire
b) On towers	On 1.5 times the projected areas of members on the windward face of towers	
c) On insulator strings:		
1) Suspension	100 kg	100 kg
2) Tension	300 kg	300 kg
B-8.2.2 ***Deviation Loads***	Transverse components tension of bundled conductors and ground wire	a) *Suspension Towers* Transverse component corresponding to 50 percent of the tension of bundled conductors or 100 percent of the tension of groundwire b) *Tension Towers* Transverse component corresponding to 100 percent of the tension of bundled conductor/groundwire

B-8.3 Vertical Loads

B-8.3.1 *Due to Conductors*	*Normal Condition*	*Broken Wire Condition*
a) Suspension towers	Equal to maximum/minimum weight span of bundled conductors	60 percent of maximum/minimum weight span of bundled conductors
b) Tension towers	Equal to maximum weight span of bundled conductors (downward or upward)	60 percent of maximum weight span of bundled conductors (downward or upward)

B-8.3.2 *Due to Groundwires*	*Normal Conditions*	*Broken Wire Condition*
a) Suspension towers	Equal to maximum / minimum weight span of groundwire	60 percent of maximum/minimum weight span of groundwires
b) Tension towers	Equal to maximum weight span of groundwire (downward or upward)	60 percent of maximum weight span of groundwires (downward or upward)

B-8.3.3 *Due to Insulator and Conductor Accessories* Equal to weight of insulator strings, spacers, dampers, etc.

B-8.4 Longitudinal Loads

B-8.4.1 *Due to Power Conductor*	*Normal Condition*	*Broken Wire Condition*
a) Suspension towers	*Nil*	50 percent of the tension of bundled conductors
b) Tension towers	Equal to the tension of bundled power conductors for dead-end towers only	Equal to the components of tension of the bundled power conductors corresponding to the relevant angles of deviation

B-8.4.2 *Due to Groundwire*	*Normal Condition*	*Broken Wire Condition*
a) Suspension towers	Nil	Equal to the tension of groundwire
b) Tension towers	Equal to the tension of groundwire for dead-end tower	Equal to the components of tension of groundwire corresponding to the relevant angles of deviation

B-8.5 Erection Loads

	Normal Condition	*Broken Wire Condition*
B-8.5.1 *Man with Tools*	150 kg	150 kg
B-8.5.2 Loads due to lifting tackles, line car, etc (to be considered at conductor cross-arm and lifting points)	350 kg	350 kg

NOTE — The design of towers shall be based on the loading combination and condition which is more stringent for the particular member.

B-9 PERMISSION STRESSES, SLENDERNESS RATIOS, MINIMUM THICKNESS, NOT EFFECTIVE AREAS, ETC — As in IS 802 (Part 1) : 1977

B-10 FACTORS OF SAFETY

B-10.1 Towers

a) Normal condition	2.0
b) Broken wire condition	1.5

B-10.2 Foundations

a) Normal condition	2.2
b) Broken wire condition	1.65

B-10.3 Coductors and Earthwire

For maximum of tensions corresponding to 2/3 maximum wind pressure at minimum temperature or maximum wind pressure to the mean annual temperature such that the initial unloaded tensions at the mean annual temperature do not exceed 35 percent of their ultimate tensile strengths and the final unloaded tensions at the mean temperature do not exceed 22 percent of ultimate strength of the conductor and 20 percent of the ultimate strength of groundwire	2.0

B-11 TESTS — As in Part 2 of this standard

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act,* 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country

Copyright

BIS has the copyright of all its publications No part of these publications may be reproduced in any form without the prior permission in writing of BIS This does not preclude the free use, in course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations Enquiries relating to copyright be addressed to the Director (Publications), BIS

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments Standards are also reviewed periodically, a standard along with amendments is reaffirmed when such review indicates that no changes are needed, if the review indicates that changes are needed, it is taken up for revision Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards Monthly Additions'

This Indian Standard has been developed from Doc : No. ETDC 60 (2967)

Amendments Issued Since Publication

Amendment No	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110 002
Telephones 2323 0131, 2323 3375, 2323 9402 *Website* www bis org in

Regional Offices:		Telephones
Central	Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110 002	2323 7617, 2323 3841
Eastern	1/14, C I T Scheme VII M, V 1 P Road, Kankurgachi KOLKATA 700 054	2337 8499, 2337 8561, 2337 8626, 2337 9120
Northern	SCO 335-336, Sector 34-A, CHANDIGARH 160 022	260 3843, 260 9285
Southern	C I T Campus, IV Cross Road, CHENNAI 600 113	2254 1216, 2254 1442, 2254 2519, 2254 2315
Western	Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400 093	2832 9295, 2832 7858, 2832 7891, 2832 7892

Branches: AHMEDABAD BANGALORE BHOPAL BHUBANESHWAR COIMBATORE FARIDABAD GHAZIABAD GUWAHATI HYDERABAD JAIPUR KANPUR LUCKNOW NAGPUR PARWANOO PATNA PUNE RAJKOT THIRUVANANTHAPURAM VISAKHAPATNAM

Ankita Art ~~Printers Ph 26814834, 41406468~~